École Normale Supérieure (PSL)

Master IMaLiS M1

Year 2025–26

Mathematics II : What biologists might like to know

Program

In charge	**:**	Amaury Lambert
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Lecturers	**:**	AL and Antoine Anastassiades (`antoine.anastassiades@espci.psl.eu`)
Timetable	**:**	Each session lasts 3 hours and starts at 9 am
Location	**:**	All lectures take place in Room 324, including computer-based tutorials (CBT)
Prerequisites	**:**	L3 course "Mathematics I : What biologists should know".

1. **Fri 19 Sep.** Harmonic analysis (I). Fourier series. Fourier transform. Characteristic function.

2. **Fri 26 Sep.** Dynamical systems (I). Invariant sets, irreducible sets, attractors. Ergodic measure. Ergodic Theorem.

3. **Fri 3 Oct.** Dynamical systems (II). Lyapunov exponent. Canonical examples : Bernoulli shift, logistic map.

4. **Fri 10 Oct.** Probability (I). Time-discrete Markov chains. Reminders, stationary distribution, hitting probability. Canonical examples : random walk, Bienaymé–Galton–Watson process, Wright–Fisher model.

5. **Fri 17 Oct (CBT1).** Harmonic analysis (II). Introduction to programming in Python. Fourier calculus. Central Limit Theorem.

6. **Fri 24 Oct (CBT2).** Dynamical systems (III). Chaotic population dynamics, May's logistic model, Lorenz attractor.

7. **Fri 31 Oct.** Probability (II). Time-continuous Markov chains. Definition, Kolmogorov Equations. Transition rate, notion of generator. Canonical examples : time-continuous random walk, linear birth-death process, Moran model. Stationary probability, hitting probability.

8. **Fri 7 Nov.** Probability (III). Brownian motion and stochastic differential equations. Canonical examples : Feller diffusion, Fisher–Wright diffusion.

9. **Fri 14 Nov.** Partial differential equations (I). Conservation law, transport equations, McKendrick–von Foerster Equation.

10. **Fri 21 Nov.** Partial differential equations (II). Heat equation, reaction-diffusion equations, Fisher-KPP Equation.

11. **Fri 28 Nov.** No class (PSL week).

12. **Fri 5 Dec (CBT3).** Probability (IV). Diffusion processes in neuroscience and in ecology.

13. **Fri 12 Dec (CBT4).** Partial differential equations (III). Simulation of a few PDEs.

14. **Fri 19 Dec.** Working session on project (in presence of A. Anastassiades).

15. **Fri 23 Jan.** Assessment (oral presentations, in presence of AL and AA).